

XXIII.—RAISING SALMONOIDS IN INCLOSED WATERS.

BY DIRECTOR HAACK.*

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It is a fact often deplored by the friends of fisheries and pisciculture that the finest of our streams, the beautiful mountain brooks, which, clear as crystal, merrily leap from rock, to rock, are, from year to year, less and less suited to fulfill their original purpose, viz, to form the habitation of fish and other aquatic animals.

The water of most of our mountain streams in these days only serves as the motive power of turbines, as the means for washing cotton goods, bleached with chlorine, as the purifier of printed cotton goods after having been treated with phosphoric or hydrochloric acids, as the receptacle for all sorts of chemicals from dye-works and chemical establishments; in fact, it serves for everything imaginable, with the exception of its original purpose, viz, to be the habitation of fish.

Wherever any water-power can be discovered we shall soon find a dam by which the whole brook or river is hemmed and its water led into some channel where it serves some industry. The manufacturer, of course, does not care whether there is enough water left in the river to allow fish to live and flourish. All this is very much to be deplored, but in most cases it can scarcely be changed; for a factory employing hundreds of men and putting millions of money into circulation certainly does more for the general good of mankind than a few trout or salmon.

Even the most enthusiastic friend of fish and the fisheries will have to familiarize himself with the idea that in course of time our small mountain streams will contain but few or no fish, simply because the large factories have driven them away. If, consequently, we do not wish to lose entirely the highly esteemed inhabitants of our mountain streams, the trout and similar fish, ways and means will have to be found to preserve these fish. This may be done by raising salmonoids in inclosed waters.

Besides the brook-trout, the lake-trout and the saibling are particularly suited for raising in inclosed waters; but all these fish are excelled by the bastards of trout and saibling. Such bastards outgrow the fish of a pure breed very considerably even when they are raised under exactly the same conditions. Besides rapid growth, such bastards possess another advantage in their exceedingly delicate flavor, combining the excellence of the saibling with the peculiar flavor of the trout. I must,

* HERR DIREKTOR HAACK: "*Einiges über die Zucht der Salmoniden in geschlossenen Räu-
men.*"—[Translated by HERMAN JACOBSON.]

therefore, consider the bastard of saibling and trout as the most suitable fish for raising in ponds.

Our beautiful aesche or grayling (*Salmo thymallus*) is unfortunately not suited for raising in ponds, principally because it is confined to insect food. This is all the more to be deplored, as this fish is particularly sensitive to the impurities of the water.

The huchen (*Salmo hucho*), on account of its great voracity and because it never eats anything that is dead, is only suited for raising in ponds where there are large numbers of small and otherwise worthless fish.

The experiments in raising the finer species of *Coregonus*, e. g., the *Coregonus marana* and the *Coregonus Wartmanni*, in ponds are of too recent a date to pronounce an opinion upon them. But so far these experiments have been encouraging.

The only salmonoid which has been raised in ponds for any length of time is the trout. Thus the trout-ponds near the Wolfsbrunnen at Heidelberg are widely known, as are also the trout-ponds of several fish dealers, e. g., those of Peter Haenlein, at Mombach, near Mayence, of Mr. Leyfried, and Helmstätter Brothers, near Würzburg.

Trout are not raised in any of these ponds, but merely fattened. The dealers buy, often at a great distance, young trout measuring 5 to 6 inches in length, which have been caught in brooks, and place them in their ponds. Here they are sorted according to years and fed with the worthless cyprinoids which are caught in large numbers in the Neckar, the Rhine, and the Main. In Heidelberg and Würzburg these food-fish are generally placed in the ponds alive, but in Mayence they are only put in dead. The former method of feeding is more convenient and may especially be recommended in small ponds where the trout have not to hunt far for their food. The method of feeding with dead fish adopted in Mombach, near Mayence, is better calculated to fatten the trout.

The food-fish are kept at Mayence in a live condition, and are every day at a certain time taken to the neighboring village of Mombach, where the trout get them dead but entirely fresh. Great care is taken that the trout leave no remnants, and the excrements and scales of the food-fish are carefully removed every day.

In all the places which have been mentioned the quantity of spring water used for feeding the ponds is comparatively small; nowhere is it more than can be conveyed by a pipe measuring about three and a quarter inches in width. At the Wolfsbrunnen, near Heidelberg, the quantity of water used for feeding the trout-ponds was larger, but since most of the water is used by the city water-works, the ponds have to manage with less water.

In Würzburg and Mayence the trout-ponds are quite small, properly speaking, only large tanks made of wood and cemented, which may be laid dry and cleaned at any time.

The Heidelberg ponds are much larger, and are, as far as I know,

only cleaned once a year, late in autumn. Special care is taken to remove the leaves which during summer and autumn are blown into the ponds. These leaves thoroughly soaked with water sink to the bottom of the pond and form the principal breeding place of the hurtful small leeches, which, if once settled in a pond, can scarcely be exterminated.

A fish-dealer in Frankfort-on-the-Main fattens the trout in a still simpler manner. As there is not sufficient spring-water in Frankfort for feeding the trout-ponds, Schauermann Brothers, of that city, have large floating boxes in the Main, which are used as trout-ponds. In autumn, when the water of the Main has sufficiently cooled off, medium sized trout caught in brooks are placed in these boxes and are amply fed with live fish. The trout can, of course, only remain in these boxes till the beginning of summer, but by that time their weight has been doubled or trebled.

The most interesting method of fattening fish is undoubtedly that of Mr. Kuffer, superintendent of the royal fisheries at Munich. It is really a pleasure to see how this Nestor of pisciculturists manages his establishment. Partly in small stone troughs and partly in small ponds trout may be seen by the hundred weight, not only alongside of each other, but in a literal sense above each other. In some of the stone troughs there are certainly more trout than water; but not only trout; but the magnificent saibling of the Schlier Lake, large *Salmo hucho*, enormous numbers of splendid eels from Italy, and, above everything else, hundreds of thousands of the finest crawfish are here gathered within a narrow space and enjoy the most careful treatment.

Mr. Kuffer's establishment is highly favored by its natural location and by the peculiarity of the Munich fish-trade. Powerful springs rise from the two so-called "ports" in the almost perpendicular wall of rocks forming one side of the court-yard. Summer and winter these springs flow from the rock with the same strength, the same temperature, and with ever clear and sparkling water; and thus it becomes possible to keep such large numbers of trout and other fish within such a small space.

In one court water from the river Isar can be brought in for the special benefit of the cyprinoids; and the experience of many years has convinced Mr. Kuffer that this mixed water is absolutely necessary to acclimatize the saibling which have been imported from the Schlier Lake. If these fish were immediately put into pure spring-water they would soon suffer from the byssus and would die.

The peculiarity of the Munich fish-trade greatly favors this method of keeping fish, as nearly every one buys his fish after the scales have been taken off and after they have been cleaned. In this manner Mr. Kuffer obtains a great quantity of entrails, and especially roe, of which all fish are very fond.

The trout and the *Salmo hucho* are not only fed with fish-entrails, &c., but also with live cyprinoids. It is very interesting to observe the great

economy with which Mr. Kuffer manages his establishment. Absolutely nothing is lost. Dead fish and remains of fish which are refused by the trout are given to the crawfish, which besides this receive a great deal of vegetable food, especially corn soaked in water.

Mr. Kuffer knows nearly every one of his fish, certainly all the larger ones. Some especially large and beautiful specimens of *Salmo hucho* and of trout have been in Mr. Kuffer's care for a number of years. Particular attention is of course paid to the female trout, the egg-producers, as the sale of eggs in the various stages of development forms no inconsiderable source of income. It is interesting to see how carefully Mr. Kuffer treats his fish. As soon as any one has the least sore place or shows the slightest trace of byssus, as soon as a fish does not swim about with its accustomed liveliness, it is taken out of the larger pond or tank and placed in a special department. Here it is kept until it has entirely recovered, or, as is mostly the case, it is as soon as possible utilized in the most profitable manner. Epidemics which are so frequent in other piscicultural establishments have never occurred in Mr. Kuffer's establishment, probably because they are checked in the bud by immediately removing diseased fish.

The crawfish epidemic, which is constantly advancing further east, has made some ravages in Mr. Kuffer's establishment.

As regards the treatment of fully-matured trout, Mr. Kuffer stands without a rival.

Pisciculture proper, *i. e.*, the raising of food-fish from impregnated eggs, is not carried on to any extent in Mr. Kuffer's establishment. There is too little room and too little time for this.

Regarding those establishments in which food-fish are raised from impregnated eggs, I cannot report as favorably as on those establishments where fish are merely fattened.

The reasons why most of our piscicultural establishments proper do not flourish are manifold. The chief cause, however, has been carelessness in the selection of a location. And where the location and the condition of the water were favorable, it was often impossible to procure suitable food in sufficient quantities, at any rate at a reasonable price.

A beginner in pisciculture is generally mistaken as regards the quantity of food required, thinking that it is sufficient to let a proper quantity of water flow through his ponds, but forgetting that fish live *in* the water but not *by* the water.

Principally owing to this question of feeding the fish, most attempts to raise trout in small ponds have remained experiments.

I also know establishments whose location enables them to procure at all times a sufficient quantity of food, but whose supply of water is not sufficient.

The largest and most successful establishment for raising salmonoids is undoubtedly the one belonging to the Klein Brothers, at Illhäusern, in Alsace. During a period of four years a quantity of trout had been

raised in this establishment, valued at 150,000 francs. This flourishing establishment has unfortunately been totally inundated and partly destroyed by the freshets in the Rhine and the Ill during the year 1874. Nearly all the trout were lost, and since that year this establishment has not been in operation.

Besides the natural food which the Ill supplied in considerable quantities, horseflesh was exclusively used for feeding the fish. The horses which were slaughtered were always carefully examined by veterinary surgeons, and the flesh was fed to the fish in accordance with their size; the larger ones got it chopped up in small pieces, and the young fish, ground fine. Two horses were generally used every week. As skin and bones were profitably sold, the horseflesh generally cost the establishment 3 to 4 cents per kilogram, and often much less.

The establishment over which I preside, during the first years was very successful in the raising of trout, and I used horseflesh exclusively for food. It was salted and came packed in barrels from Mülhausen, in Alsace. It was the very best meat, free from sinews and bones, and cost me, including cost of transportation, 4 to 6 cents per kilogram. I kept a very careful account of my expenses for food, and found that it cost me from 50 cents to 73 cents to raise 1 kilogram of trout. Considering that trout sell at \$1.25 to \$1.50 per kilogram, my profit was considerable. In this calculation, however, I have taken no account of the natural food which the trout find in the larger ponds containing aquatic plants. By this method of feeding, some trout weighed 2½ to 3 pounds when two and a half years old. Unfortunately I had to give up this method, as, doubtless owing to some infected meat, an epidemic broke out among my trout and carried off every one of them.

There can be no doubt that the epidemic was caused by infected meat, since it broke out on the same day in all my ponds, many of which had no connection whatever with each other. Not only the larger fish, but also those which were only a few months old, in fact, all my salmonoids, died in one day.

For several reasons I could not buy the horses alive and have them examined and slaughtered at my establishment, and I was consequently obliged to give up this method of feeding fish. I must say that I have not obtained a similar success with any other food.

I am told that the establishments at Aubach and Baitzenburg are worked on the same principle, though I do not know with what success.

In raising saibling in small ponds, the greatest success in Germany has been obtained by Mr. Wieninger, at Teisendorf, in Upper Bavaria. Here may be seen within a small space many thousands of great and small saibling, all raised from the egg.

It is truly astonishing that so large a number of fine fish can be raised with so little change of water. I must warmly recommend this establishment to all persons interested in pisciculture.

The establishment at Hellbrunn, near Salzburg, is also very successful in raising saibling.

Both these establishments use horseflesh as food, but as nearly the whole population of these poor mountain regions lives on horseflesh, it is more expensive than in most other places, and the profit is consequently not as large.

Although the price of fish is high in those parts, saibling fed in this manner fetch a higher price than those caught in the lakes.

These establishments are, nevertheless, very instructive, for they prove the possibility of raising large quantities of salmonoids within a narrow space, and of raising fish from impregnated eggs till they are fit for the market.

As very little capital is required for starting such establishments, they would certainly be a source of profit if a less expensive article of food could be found, or if they could be started in places where horseflesh is cheaper.

Saibling are also raised in numerous private establishments in Austria and Bavaria, which are all more or less successful.

This fine fish certainly deserves the great care which it enjoys in many places.

In the following I shall give my views regarding the raising of salmonoids in inclosed waters.

Before spending any money in starting a piscicultural establishment, a man ought to inform himself as accurately as possible regarding the water which will be at his command. He must know the average quantity of water, counting in the dry season; he must know the temperature of the water during the greatest heat and the greatest cold, and also the exact nature of its fall on the territory in question.

Every beginner should also not only inform himself theoretically, but practically, and this object will best be attained by visiting some prominent piscicultural establishments. The best season of the year for such visits is in March and April, because in well-regulated establishments everything of importance can then be seen to the greatest advantage. Although such hints seem almost superfluous, they are nevertheless much needed.

Large piscicultural establishments have been started by men who possessed little practical and no theoretical knowledge. People will begin, not with 5,000 to 10,000 trout eggs, but with hundreds of thousands, yea, millions of eggs, in the hope that large profits will quickly be realized. If—as will generally be the case—these profits do not come; if, on the contrary, failure is succeeded by failure, the whole cause is condemned, and we often hear it said: "So-and-so has also commenced to raise trout, but of course nothing came of it! Pisciculture is a delusion!"

It is just as difficult to make millions of money in pisciculture as in anything else. An intelligent, thrifty, and, above everything, persevering and hard-working man, will always realize some profits from this as yet comparatively little known industry, especially as long as there is

not much competition. But he who thinks that pisciculture will in a short time make him a rich man had better engage in any other occupation, for there is scarcely any branch of human industry which requires such constant personal attention and work as pisciculture!

But my zeal for a good cause has led me too far from my subject.

If a locality does not offer a sufficiently large quantity of water; if there is little or no fall; if there is no absolute safety from freshets, no extensive establishment should be started, but a more favorable place should be selected, even if the first expense be greater.

By carefully ascertaining the temperature of the water both during winter and summer, the pisciculturist will know what salmonoids he will be able to raise.

Saibling can only be raised in places where the water, even during the hottest season, does not reach a temperature higher than $+ 14^{\circ}$ Réaumur (64° Fahr.). A higher temperature, even if the water is changed frequently (63.50° Fahr.), will kill all the fish.

I am not able at the present time to say exactly what degree of temperature the bastard of trout and saibling can stand, as I have not yet concluded my observations on this subject. But as regards trout—both brook and lake trout—I am prepared to say that they can stand a much higher degree of temperature than is generally supposed. If the change of water does not take place too slowly, trout can live in any river-water. I have already observed that the temperature in ponds has reached 22° to 23° Réaumur (81° to 84° Fahr.) without causing the slightest disadvantage to the trout. During a high temperature the change of water must of course be frequent and rapid. If the temperature is very high the trout is not quite as voracious as otherwise, but does not suffer in any way.

I must in this connection mention the following fact:

During last summer I ascertained, by numerous and accurate observations, that our German trout can stand a much higher degree of temperature than the American *Salmo quinnat*, which had been so highly recommended to us on account of its power of resistance to warmth. In three of my ponds the influx of Rhine-water suddenly ceased during the hottest part of summer, because the Rhine-Rhone canal was laid dry. In consequence, all my California salmon died in a very short time, while nearly all my German brook and lake trout remained alive.

The beginner in pisciculture will see from the above what kinds of salmonoids it will be most profitable to raise.

It is not the object of the present brief treatise to give exact rules for raising the various salmonoids from the earliest stage of their development, as this would require more space than is offered by the circulars.

I must, therefore, confine myself to a few general hints, hoping that at some future time I may be allowed to enter more into details.

I, therefore, begin with the treatment of the young fish after they have lost the umbilical bag, *i. e.*, have become able to seek their own food.

As a general rule the work of most pisciculturists is done as soon as their young trout or salmon have lost the umbilical bag, and nothing remains to be done but to place the young fish in suitable locations in brooks and rivers. But the chief work of him who wishes to fatten his fish for the market in inclosed waters only commences at this point.

There will be a difference in the method of raising trout and saibling.

According to my experience the simplest and best method for trout is to place the young fish, as soon as the umbilical bag has disappeared, or, better yet, a few days previous, in a small artificially-meandering brook and leave them there till autumn. This brook must be so arranged that the influx of water can be thoroughly regulated. In the beginning the water must flow in only in small quantities and gradually increase till the middle of summer, when the influx can scarcely be strong enough. This artificial brook should, if possible, be arranged in close proximity to some natural brook, but so that it cannot be injured by high water. The well-closing grates at the entrance and exit should be movable, so that coarser grates can be substituted when the fish grow larger and the influx of water is stronger. The most suitable material for such grates is a piece of perforated tin. It is understood that such an artificial brook must have artificial hiding places made of stones, broken pieces of drain-pipe, boards, and suitable aquatic plants. In this brook the trout are left till October or November. If it is of considerable extent and not overcrowded with fish, artificial food is scarcely needed.

Before new fish are placed in the brook in autumn even the last of the young fish must be removed. In order to do this, it is absolutely necessary to remove even the last drop of water from the brook. It is better that a few of the one-year old trout should perish than that a single one should remain. The danger that a larger trout will devour the majority of the new fish is of course much greater in an inclosed than in an open brook, as in the latter there are so many more natural hiding-places.

In raising saibling and bastards of saibling I consider it necessary to keep them during the first year in small, thoroughly inclosed waters, and to feed them with artificial food. All my attempts to raise saibling in the same manner as trout have only yielded negative results. The young saibling which, in those deep waters where it is accustomed to live, has never met with an enemy, has completely forgotten how to fight for its existence.

It is very interesting to observe how different the mode of life of the trout is from that of the saibling, even from their earliest youth up.

Young saibling are not at all shy, and when the inclosure is opened they will not fly but come quite close, while trout raised in exactly the same manner will nearly always remain shy, and certainly fly rapidly whenever the inclosure is opened. It is no rare occurrence that young trout, whenever their inclosure is opened, shoot off with such rapidity as to become stunned by bumping against the sides, and even to become fatally injured.

Young saibling, as well as young trout, unless placed in large artificial brooks, should at first be fed exclusively on small crustaceans. Although it may in some localities involve trouble and expense to procure such living food, it is everywhere possible to obtain it. As soon as the young fish have grown a little larger the larvæ of various kinds of gnats, which surely can be obtained everywhere, are a most suitable food. Only after the young fish have for several weeks been exclusively fed on live food, artificial food should be given to them. The best food for all young salmonoids will under all circumstances be the brain of cattle, ground fine. With a sharp brush the brain is rubbed two or three times through a close wire-sieve, and this sieve is then washed out in the artificial brook close to the entrance. In the beginning but very little should be given, and all the remains should be carefully removed; gradually, however, the quantity should be increased. As soon as the fish are a few months old the feeding process will gradually become easier, and the brain should then be rubbed through a coarse sieve. But rarely will any particle of the brain fall to the bottom, as the fish will greedily devour it all. At this period it will be well to vary the food a little; and I can conscientiously recommend raw meat of the muscle part, for the smaller fish, of course chopped fine. Wherever there are properly inspected horse slaughter-houses horseflesh may be used, which is of course cheaper; but wherever you are not absolutely certain of obtaining healthy flesh, the more expensive beef should be used. The little trouble and expense should not prevent any one from giving the young fish from time to time worms chopped fine, as well as the larvæ of the phryganids carefully removed from their shell, which are found in great abundance in every water. The small expense incurred by thus varying the food will be amply repaid by the better condition of the fish.

The chief point in feeding fish in inclosed waters will be to observe the greatest cleanliness; and the basins should every day be carefully cleaned of all remnants of food and excrements. It will, therefore, be found advantageous to place the young fish in elevated basins, so that all remains of food &c., can be removed by means of a gutta-percha tube.

As long as the fish are quite small such a tube should be furnished with a fine sieve. If the basins are not elevated the cleaning must be done by means of a pipette.

The most scrupulous care in removing all remnants of food and dirt from inclosed waters is absolutely required for raising salmonoids. In natural brooks, which have an abundance of aquatic plants, the numerous small crustaceans keep the water sufficiently clean, while in artificial brooks man must be the scavenger.

During the first year no food can be too expensive, as the quantity of food required is not very great. I have kept an exact account, and even when using brain, which is the most expensive food, from spring till

autumn (the time when fish eat most), it never cost me more than $\frac{1}{2}$ to $\frac{3}{4}$ cent apiece. When fed in this manner the fish had reached an average length of a finger; the expense had therefore not only been amply repaid, but the gain was infinitely larger than the expense. Such a young saibling or bastard is worth at least 4 to 5 cents and even more, for its period of growth is only just commencing. I say advisedly "period of growth," for during the first year fish grow most rapidly, comparatively speaking. After having lost the umbilical bag a trout weighs about 0.125 grams; and as a trout when one year old will, if well fed, weigh 20 to 25 and even 30 grams, the original weight has increased about 200 fold. Growing at the same rate, a trout when two years old would weigh about 4 or 5 or even 6 kilograms. Well-fed saibling are ready for the market when two years old.

As soon as the fish grow larger the question of feeding them becomes more important; for a larger quantity of food is required. Expenses should now be carefully calculated, for otherwise it may happen that artificially-raised fish are twice and three times as expensive as those caught in open waters.

This question of food is really the main question in raising salmonoids in inclosed waters; and so far this question has not even been answered approximately.

As I have already mentioned, the raising of salmonoids will be profitable in such places where small food-fish, principally of the *Alburnus* and *Leuciscus* kind, which never grow large enough to serve as food for man, can easily be obtained. There are a great many such places, and whenever all the other conditions are favorable salmonoids can be successfully raised.

To feed the young fish exclusively with meat—on account of the cheap price, it will have to be horse-flesh—has many serious disadvantages, and I would not advise any one to introduce this method of feeding in any large piscicultural establishment.

Two years ago I thought I had discovered the right method, and commenced to feed my salmonoids with herrings. The trout and saibling ravenously devoured the herrings, which had been soaked for twelve hours and then chopped fine. But soon I discovered that great caution had to be used in this method of feeding, because even the cheapest herrings are very fat and hard to digest.

As an occasional food I can recommend herrings, because at times they can be bought very cheap, and because salt herrings can be kept for years. You are therefore certain of having food all the year round.

It would be advisable to make experiments with using salt-water fish as food, because they are at certain seasons of the year cheap and to be had in great abundance.

The smelt, *e. g.*, which at times are caught in large numbers, would certainly form an excellent food for salmonoids. There are other fresh-water fish besides the *Alburnus* and *Leuciscus* which might be very ad

vantageously used as food for trout; thus, *e. g.*, the crucian carp, which in North Germany is found in enormous numbers in every little pond. Such little ponds are, on account of the great fecundity of the crucian, so densely populated that these fish became absolutely worthless as an article of human food. As the crucian is a very hardy fish, and can easily be transported long distances, there is a possibility of feeding large numbers of trout with live fish.

I was therefore deeply interested in the views expressed some time ago in the *Deutsche Fischerei-Zeitung*, by Mr. Dallmer, superintendent of fisheries, that certain portions of his district increased their production of trout very considerably by using the crucian as an article of food. This production should be still higher in the neighborhood of large cities, such as Hamburg, Bremen, Hanover, and Berlin, because there salt-water fish can at times be bought very cheap.

As long as trout will bring \$1.20 to \$1.42 per kilogram, there is no fear that a well-arranged piscicultural establishment, well supplied with suitable food, will not pay.

The raising of salmonoids in inclosed waters is an industry which has been by far too little developed, and which most assuredly has a great future.

I shall endeavor as far as possible to give a clear idea of this industry at the coming International Fishery Exposition.

Quite young salmonoids, as well as some one and two years old, will be exhibited in inclosed waters and be fed in a rational manner.

It is my earnest hope that many new followers may be gained for this important branch of industry, to which I have given special attention for quite a number of years.

